LONGEVITY OF WATER-BORNE SELENIUM FROM COAL MINE OPERATIONS IN ALBERTA

EXECUTIVE SUMMARY

Luscar and Gregg River coal mines ceased operations in the early 2000's. Annual environmental reports from 2014 and 2017 for these coal mines contained data on selenium concentrations in surface water at key locations, since their closure. The reports show reductions of 24 to 87 % of selenium concentration over a period of 8 to 18 years-of-record, respectively, since the mines ceased operations.

Surface mining of coal occurred historically in the Blairmore area between 1956 and 1978. The Grassy Mountain Application for coal mining documented that selenium concentrations in water seeping from the toe springs of rock dumps from this previous surface mining at Grassy Mountain ranged from 0.1 to 2.6 μg/L in 2015 – 37 years after mining ceased.

Citations in the public press that selenium contamination in surface water will last for "thousands of years" after mining are without factual basis.

INTRODUCTION

Selenium-reduction technologies have been developed to be applied to surface water at existing and new metallurgical coal mines in Alberta and British Columbia. The discussions around these technologies are not able to consider natural, temporal reductions in selenium concentrations and are therefore unable to set an endpoint for application of selenium treatment. This is because of a lack of documentation of any natural reductions in selenium concentrations in surface water associated with discontinued mining operations.

There have been recent statements that selenium *contamination* from new mountain mines in Alberta will last for "thousands of years". The information examined here demonstrates that natural reductions do occur after mining ceases and that selenium concentrations will decrease over a relatively short timeframe.

BACKGROUND

Metallurgical coal mined in Alberta is generally derived from a geological sequence in the mountains that is very similar in age and depositional environment along a trend running from Grande Cache south to the U.S. border. It has been determined that the source of the selenium is from rock beds located above the coal seams – collectively referred to as *overburden*. Overburden needs to be removed to access the coal seams and has been shown to contain the selenium that subsequently appears in surface water.

All of the existing metallurgical coal mines along this trend have been shown to have elevated selenium concentrations measured to a greater or lesser extent in surface water runoff. The selenium sampling history of mines along this entire trend are therefore relevant to anticipate conditions which may occur anywhere along this trend.

The Luscar and Gregg River mines, located in the vicinity of Cadomin Alberta, ceased operations in the early 2000's. This means that overburden rocks containing selenium minerals were no longer being placed in rock dumps after closure. No treatment technology was, or is, being applied to reduce selenium in runoff from these mines. However, annual monitoring and environmental reports for these mines continue to be filed with regulators and are public information. Some of these reports contain historical data regarding selenium concentrations in surface water bodies receiving drainage from these two mines. Thus, a temporal perspective can be obtained of the amount of selenium being released from the inactive mining areas.

ASSESSMENT

The most-recent publicly available annual reports that contain historical data are Luscar Mine (2014) and Gregg River Mine (2017). These provide an opportunity to examine selenium concentrations for up to 13 and 18 years after closure for Luscar and Gregg River Mines, respectively. The historical information in both these annual reports is presented as graphs of selenium versus time. It was quite obvious that many of the graphs showed that selenium was decreasing with time since the early 2000's. This decrease was not steady as there was abundant variability shown on the graphs. However, it was clear, that concentrations of selenium were decreasing over the period of record.

In order to better understand the information, this assessment estimated a linear relationship over the period of record shown on each graph of a particular sampling site, and the starting and ending estimate of selenium concentration was thus determined. Tables 1 and 2 show the results of these estimates.

For example, sampling site B5SP (Table 1) had an estimated selenium concentration of 60 micrograms per liter (µg/L) in 2002 and 4 µg/L 14 years later in 2015 – this being a 93 percent reduction.

The sampling sites can be characterized into two types:

1. *Toe Springs*: These are located at the toe of external overburden dumps and reflect surface runoff water which has interacted with the contents of those dumps.
    a. Toe springs have been identified as representing a maximum exposure situation with respect to selenium in surface water runoff because the overburden has been shown to be the source of additional selenium loading to water courses. Water from these toe springs joins the overall runoff of the mine and influences the chemistry of *creeks and ponds*.

2. *Creeks and Ponds*: Water courses reflecting drainage from extended areas both within, and, possibly, above the general mine area.
    a. Selenium concentrations in creeks and ponds reflect the amalgamation of all possible selenium sources within, and in some cases, upstream of, the mine. Notably, this would include both external overburden dumps and in-pit rock dumps.

This interpretation of historical water analyses at these two mines shows:

1. A 50 to 93 % reduction in selenium concentrations in water in toe springs over a sampling period of 13 to 17 years since operation ceased, and
2. A 24 to 87 % reduction in selenium concentrations in water in creeks and ponds over an 8-to-18-year sampling period since operations ceased.

Table 1 Luscar Mine - Selenium Concentration Assessment

Sample Site	Start Year	Selenium at Start of Record (µg/L)	Selenium in 2015 (µg/L)	Number of Years (Including 2015)	Percent Reduction from start
Toe Springs					
A4SP	2002	400	200	14	50
B5SP	2002	60	4	14	93
Creeks, Ponds					
LUS5	2002	15	10	14	33
A6PO	2008	40	20	8	50
EJPO	2007	50	38	9	24
LYPO	2007	200	125	9	38
ANLK	2006	35	8	10	77
CPO	2007	10	3	9	70
MGCK02	2008	30	10	8	66
APO	2007	40	10	9	75

Table 2 Gregg River Mine - Selenium Concentration Assessment

Sample Site	Start Year	Selenium at Start of Record (µg/L)	Selenium in 2017 (µg/L)	Number of Years (Including 2017)	Percent Reduction from start
Toe Springs					
H1PITSP	2005	26	5	13	81
D12SP	2001	30	15	17	50
Creeks, Ponds					
C3PL	2001	18	7	18	61
KKPL	2001	15	5	18	66
Z1PL	2001	15	2	18	87
GBS	2005	9	5	13	44
LFC	2001	20	9	18	55
CDPL	2001	25	9	18	68
LBC	2001	15	5	18	66

In the Crowsnest Pass area, the Grassy Mountain Application provides another example of how selenium in runoff in metallurgical coal mines does decline with time. Previous surface-mining operations ceased in 1978. Sampling of four toe springs at this mine in 2015 documented selenium in runoff ranging from 0.1 to 2.6 µg/L – 37 years after mining ceased. There is no way to establish how high the selenium concentrations at these toe springs may have been at the close of mining operations, but the current concentrations indicate the likelihood of significant reductions in less than four decades.

CONCLUSIONS

The site-specific samples at the toe of external rock dumps (representing possibly a *highest-impact* location) and the creeks and ponds samples from the mine area in general, reflect approximately the same situation. That is, selenium concentrations in runoff from mines along the metallurgical coal trend of Alberta will decline with time even without the application of mitigative measures implemented to capture and treat selenium using modern technologies prior to release to the environment.

Stating that selenium contamination in surface water from metallurgical coal mines will exist for thousands of years is without any basis in fact. Site specific data from historical mines demonstrate that selenium concentrations in surface water decrease with time, in a relatively short time frame of “tens of years”. This reduction is occurring naturally without any applied reduction technology at the source to mitigate release to the environment.

It can be anticipated that selenium reduction technologies applied to new metallurgical coal mines will not be expected to operate indefinitely after mine closure. Natural, post-mining reductions in selenium in surface water runoff will occur and treatment can be expected to terminate at some appropriate time.